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Fault at Five Springs Creek, Wyoming

By John R. Wingert

As part of a thesis project, field work was done on the west flank of the northern Bighorn Mountains, Wyoming. One of the more interesting structures in the area was an eastward dipping reverse fault, at Five Springs Creek. Such faults are common in this part of the mountains, in contrast to westward dipping thrust faults on the east flank.

Location and Description

The fault is located about 23 miles east of Lovell, Wyoming, on state highway 14. At the base of the mountain flank, about two-thirds of a mile south of where the highway crosses Five Springs Creek, the green fossiliferous shales of the Jurassic Sundance formation lie on top the overturned black Thermopolis shales. The Morrison and Cloverly formations, with a total thickness of 450 feet, are both missing. Because of poor exposures, the fault trace is apparent only a short distance; however, a maximum length of four miles is suggested by the overturned beds. Little of the fault is visible; however, it appears to dip 20° N. 50° E., with a heave of approximately 600 feet.

Figure 1, cross section A-A′ along Five Springs Creek, shows the reverse fault and the associated overturned beds. The Bighorn Basin, with gently westward dipping beds, is to the southeast. The Jurassic Sundance and Gypsum Springs formations, Triassic Chugwater, Permian Embar, Pennsylvanian Tensleep and Amsden formations are overturned, dipping northeastward 60 to 70 degrees. The Mississipian Madison limestone beds are overturned about 80 degrees or are vertical with overturning in only the upper part. The Ordovician Bighorn dolomite is vertical to slightly westward dipping. The Cambrian Flathead sandstone, Gros Ventre shale, and Gallatin limestone dip 45 degrees to the southwest. In cross section the beds have a fan-like appearance, with increased overturning in the basinward direction.

Figure 2 is a cross section through the fault about one-half mile southeast of the creek. All the Bighorn beds are overturned, as well as the Gallatin and much of the Gros Ventre. The Cambrian beds at elevations of 8000 feet and higher are nearly horizontal, lying on the peneplane surface at the top of the Precambrian crystalline rocks.

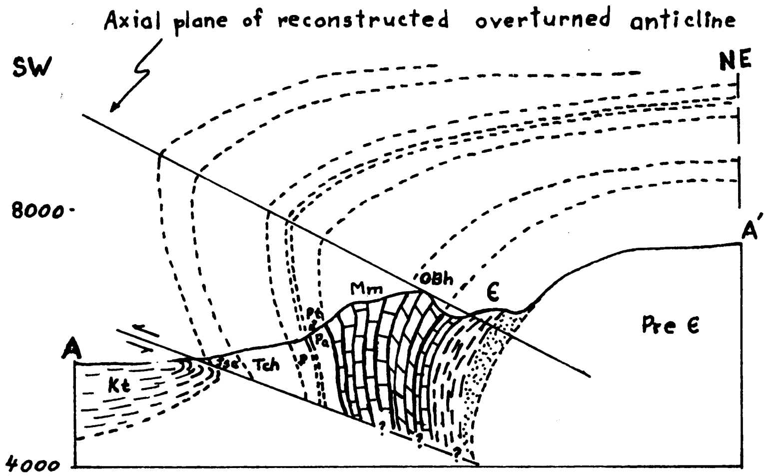

Figure 1. Reverse fault and reconstructed overturned anticline. Cross section dra Springs Creek.

Kt = Cretacious Thermopolis shale
JSG = Jurassic Sundance and Gypsum Spring fms.
Tch = Triassic Chugwater fm.
P = Permian Embar fm.
Pt = Pennsylvanian Tensleep ss.
Pa = Pennsylvanian Amsden fm.
Mm = Mississippian Madison lms.
OBh = Ordovician Bighorn dolomite
C = Cambrian Gallatin, Gros Ventre, And Flathead fms.
PreC = Precambrian crystalline rocks
Scale: 1 inch = 2,640 feet

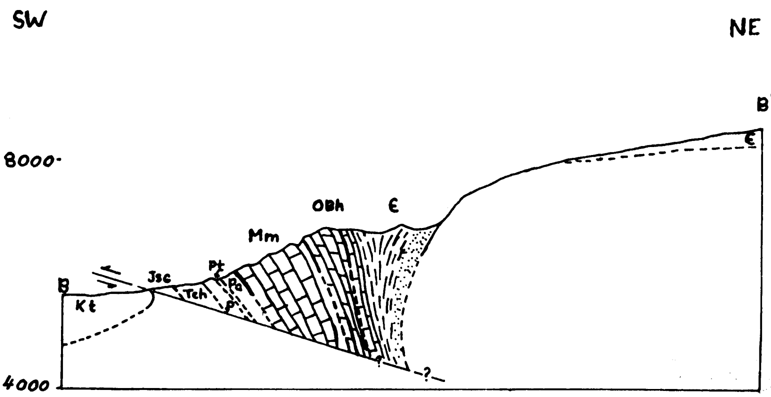

Figure 2. Five Springs Creek reverse fault. Cross section one-half mile southeast of

Interpretation

Only surface data are available, and because they are limited the nature of the bedding and fault at depth are speculative.

Wilson (1934, pp. 501-504) has interpreted this fault as an overthrust, with a prominent local protuberance of crystalline rocks which activated the hanging wall. He also mentioned the possibility of underthrusting, if Lovering's criteria are used.

However, I think the field evidence strongly suggests underthrusting. With only a few hundred feet of displacement along the fault, it seems probable that the western-most beds on the flank would be first and most affected if the footwall was underthrust from the basinward direction. This would be reflected in a greater amount of drag and subsequent overturning in the Mesozoic and upper Paleozoic formations in the passive hanging wall. The lower Paleozoic beds would show only partial or no overturning as is the case at Five Springs Creek. In addition, the strike of the formations swings abruptly eastward just north of Five Springs Creek. Using Lovering's criteria (Lovering, 1932, pp. 654-655), this bend suggests drag by a block underthrust from the basinward direction.

These features are not unique, however. A similar situation exists at South Beaver Creek, about nine miles to the southeast. An overturned fold, unbroken by tear faults, passes into a high angle reverse fault. Moreover, the strike of the formations also swings abruptly to the east, then southeast, and finally southwest before assuming the original southeast trend. This pattern follows a conspicuous topographic re-entrant in the mountain side.

It was noted that the beds near the Five Springs Creek fault are thicker at the surface and taper underground. This thickening could be coincident with thickening along the axial plane of an overturned anticline developed during Laramide uplift along the western flank. Figure 1 shows the reconstructed overturned anticline with thickening along the axial plane. Thickening, particularly in the Mesozoic shales, could be accomplished without significant bulging in the Precambrian granite, thus explaining progressively increased overturning in the basinward direction. Direct evidence of this is, of course, eroded away. Under these circumstances, the fault would be a thrust along the axial plane of the complementary overturned syncline.

Conclusion

Because field evidence suggests either overthrusting or underthrusting, the problem is not settled. However, the observations and interpretation of this and similar minor structures on the flanks are of fundamental importance for a clearer understanding of the regional tectonics, especially in regard to a wedge or anticlinical hypothesis for the Bighorn uplift.

Literature Cited

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